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Q•LOCK LIGHT FIXTURE CONNECTOR

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Q•LOCK LIGHT FIXTURE CONNECTOR

August 1990

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The views and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as expressing the opinions of Alberta Municipal Affairs.

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FOREWORD

The project documented in this report received funding under the Innovative Housing Grants Program of Alberta Municipal Affairs. The Innovative Housing Grants Program is intended to encourage and assist housing research and development which will reduce housing costs, improve the quality and performance of dwelling units and subdivisions, or increase the long term viability and competitiveness of Alberta's housing industry.

The Program offers assistance to builders, developers, consulting firms, professionals, industry groups, building products manufacturers, municipal governments, educational institutions, non-profit groups and individuals. At this time, priority areas for investigation include building design, construction technology, energy conservation, site and subdivision design, site servicing technology, residential building product development or improvement and information technology.

As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied. Comments and suggestions on this report are welcome. Please send comments or requests for further information to:

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Acknowledgements

The financial assistance of the Innovative Housing Grants Program of Alberta Municipal Affairs is gratefully acknowledged. It should be recognised that the support of IHGP was instrumental in enabling the inventors to seek technical assistance, and defray some of the expenses in refining and certifying the connector.

Although the project would have gone ahead without IHGP assistance, the whole process would have been extended considerably since progress would be tied to accumulation of personal savings. The financial assistance has promoted the development of the connector such that conventional sources of funding can now be approached to complete patenting, manufacturing and test marketing of the connector.

In addition to the financial support, the support and advice of staff of IHGP is gratefully acknowledged. The review comments and suggestions provided by Terry Toth of IHGP were astute, and helpful.

Fernd van Engelen, of Section Five Design, was contracted to develop the prototype and to investigate alternative designs. We wish to thank him for his contribution.

Randy Bilyk proved to be a very able demonstrator of the Q.Lock connector and offered several useful suggestions regarding its use.

Finally, the technical assistance, support and advice of Chris Foot, of Production Die-Makers and Machine Ltd, Edmonton, has made the Q.Lock connector a better product, and I wish to thank Chris for this.

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Executive Summary

The Q.Lock connector is a device which facilitates the simple, quick, and safe installation and removal of most wall and ceiling residential incandescent light fixtures. It consists of two parts - a low profile base plate that mounts on and covers the electrical outlet box, and is connected to household power; and an attachment plate that is mounted and wired to the light fixture. A simple push-and-twist action simultaneously completes the electrical connection and locks the two plates together. Reversal of that action disengages the connections.

Prior to the work of this project, the device had been developed to an initial prototype stage. Evaluation of the initial prototype revealed certain problems with the electrical and mechanical connections. The primary objectives of this project were to address those problems, complete the development of the device, and obtain product certification.

In addition to product development and certification, the work included cost and market analyses and a demonstration, which compared installation of lighting fixtures using the Q.Lock connector to the conventional method.

Governing standards, as published by the Canadian Standards Association (CSA) and Underwriters Laboratories (UL) were identified and their applicable requirements were addressed at each phase of product development. Preliminary certification inspection revealed shortcomings with respect to grounding and wiring terminal characteristics. Further examinations revealed minor shortcomings with respect to accessibility of the electrical contacts and thickness of the plastic housing. All these shortcomings were successfully addressed and the Q.Lock connector subsequently received CSA certification in January of 1990. UL certification is imminent.

Cost analysis indicated that the Q.Lock connector could be produced in low volume for the North American market at a retail price of $3.00 to $5.00 (Cdn) per unit. The North American market was estimated to be in the range of 30 to 75 million units annually and the world market is conservatively estimated at 100 to 300 million units annually.

A small-scale demonstration utilizing the Q.Lock connector illustrated the time and cost effectiveness when compared to the conventional direct connection method of installing lighting fixtures. An array of nine fixtures required approximately 3 hours and 15 minutes of installation time by conventional means. The same fixtures were fitted with the Q.Lock connector system and installed in less than 45 minutes. If the fixtures had factory mounted attachment plates, the installation time for the fixtures would be reduced to about 20 minutes in the example application.

The Q.Lock connector will provide benefits to the entire chain of participants in the housing industry, from the manufacturer through to the homeowner. Because the device is inherently safe, installation and removal of light fixtures could be done by the homeowner. A permit would not be required and it would not be necessary for the homeowner to hire an electrical contractor. Use of the Q.Lock connector would provide a competitive advantage to the electrical contractor in the preparation of contract bids. Back ordered fixtures would not present call back problems for the contractor, since they could be simply be "plugged in" by the homeowner at the time of delivery. The Q.Lock connector would facilitate earlier completion of the wiring system for a new home. It would also be an effective marketing tool for the builder, since alternative lighting fixtures could be quickly and easily installed to satisfy the buyer. Fixture manufacturers and retailers could increase sales since ease of replacing light fixtures would greatly decrease consumer reluctance to purchase new fixtures.

The Q.Lock connector demonstrates three major attributes necessary for success in the marketplace - convenience, safety, and affordability. It is expected that the Q.Lock system will become an accepted product in the housing industry marketplace.

Chapter 1

Introduction

1.1 Rationale

The Q.Lock connector is a device which eases the task of installing and changing residential lighting fixtures, with inherent improvement in the safety of such work when undertaken by the homeowner.

Three steps are required to install a light fixture in the conventional manner: (1) a hanger bar is screwed to the outlet box; (2) the supply wires from the outlet box are connected to the fixture wires; and (3) the fixture is connected to the hanger bar.

Although the conventional procedure for installing light fixtures appears to be relatively simple, in reality it often proves difficult.

Generally there is no difficulty in mounting the hanger bar to the outlet box. However, once the bracket is in place, there is some awkwardness in pushing the supply and fixture wires and connectors into the outlet box.

To make the electrical connections between the light fixture and the supply wires, the light fixture has to be held near the wall or ceiling. Two hands are required to make the electrical connections. Thus, the fixture has to be supported by the electrical connector and wiring, or an additional person or support is required to hold the fixture.

Two-point mounted light fixtures are secured to the hanger bar by screws. In practice it is often difficult to align the mounting screws through the canopy (and canopy insulation) to the threaded screw holes in the bar. In addition, the mounting screws may have to be cut to length once the fixture is mounted.

Damage to the fixture, electrical connections, and the building surface may occur. In addition, electricians have indicated that many homeowner-installed light fixtures are incorrectly wired, which is an unsafe condition.

The Q.Lock connector would make the installation of wall and ceiling fixtures comparable to plugging in an appliance. A simple female socket is wired and attached to the electrical outlet box. A matching male socket would be fitted to the light fixture, then the fixture would be connected by a push and twist action. The device is 'locked' in place so that it is not inadvertently dislodged.

The device, which can be retrofitted to fixtures or incorporated into fixtures at the manufacturing stage, would greatly simplify procedures and add new flexibility for electrical contractors and consumers.

1.2 Objectives and Format

The objectives of this project were to finalize the design, to obtain electrical certification, and to demonstrate the operation of the Q.Lock connector.

A portion of the development work for the Q.Lock connector was undertaken in a previous project. Scheduling difficulties necessitated the termination of that project at the stage of manufacturing a pre-production die. In the period between termination of that project and the present project, a pre-production die was produced and prototype castings were manufactured. That work lead to the discovery that certain design refinements were required and it is at this stage that the current work commenced.

This report describes work on the project under the following chapter headings:

- Product Development;
- Regulatory Approval;
- Cost Analysis and Markets;
- Demonstration;
- Benefits; and
- Conclusions.

Chapter 2

Product Development

2.1 Development Objectives

The objectives of the project were to complete the development of a highly functional, low cost, simple, aesthetically pleasing light fixture connector suitable for the safe and easy attachment and detachment of wall and ceiling residential lighting fixtures. Further, the device had to be able to be fitted to a wide variety of light fixture types, without modification of the fixtures, either at the point of manufacture, or by retrofitting of existing light fixtures by the homeowner, retailer or electrician.

The design process was comprised of three elements:

1. electrical and mechanical design;
2. certification requirements; and
3. prototype evaluation.

It should be emphasised that each of the design elements had to be considered simultaneously in order to achieve the project objectives. As a result, the design process was iterative, and numerous design alternatives were developed, tested and reviewed in terms of compliance with certification requirements and the objectives of the project.

A listing of applicable standards is given in Appendix A. For convenience, references to those standards are abbreviated within the body of the text in the following manner:

- CSA C22.2-42, 4.1.9.2 refers to Canadian Standards Association (CSA) Standard C22.2 No. 42-M1984, General Use Receptacles, Attachment Plugs, and Similar Wiring Devices, clause 4.1.9.2; and
- UL 1571, 22.7 refers to Underwriters Laboratories standard UL 1571, Incandescent Lighting Fixtures, section 22.7.

2.2 Electrical and Mechanical Design

In the initial design, undertaken previous to this project, numerous connector designs were considered. The designs were evaluated primarily in terms of ease of application to a variety of light fixture types (Figure 2.1) and manufacturing requirements, within the broad framework of certification requirements.

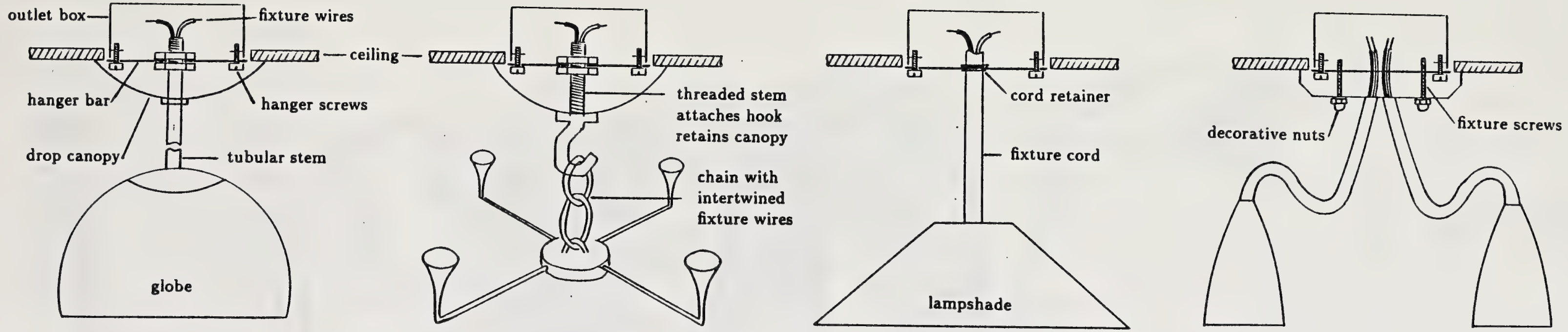
Eleven designs were made into physical models. The models had various configurations of electrical and mechanical connections, such as connectors that snapped together, sliding plates, screw connections, bayonets of various configurations, and compound bayonet and slide locking connectors. A bayonet configuration, which made simultaneous mechanical and electrical connections, provided the most satisfactory solution to the design objectives.

The main elements of the initial prototype are described in Figures 2.2 and 2.3. In summary, there are two main parts: a 'base plate' that is electrically wired to source power and fixed by screws to various sized electrical outlet boxes or directly to a building surface; and an 'attachment plate' that is built in, or retrofitted, to a light fixture.

Stem-pendant, cord-pendant, and chain-pendant fixtures (Figure 2.1) can be mounted to the attachment plate through the central aperture 20; or two-point mounted fixtures can be mounted using the slots designated 7 and 19 in Figures 2.2 and 2.3.

Mechanical connections between the two plates are made by a simple push and twist action in which the attachment plate catches (11 in Figure 2.2) interlock with the corresponding catches on the base plate (16 in Figure 2.3). There is only one way to assemble the device, thus complying with CSA C22.2-42, 4.1.9.2 polarity requirements.

Electrical connections are made at the same time as the mechanical connections. The male electrical contacts (12 in Figure 2.2), ride over sprung J-shaped contacts that are secured to the electrical terminals (3) of the base

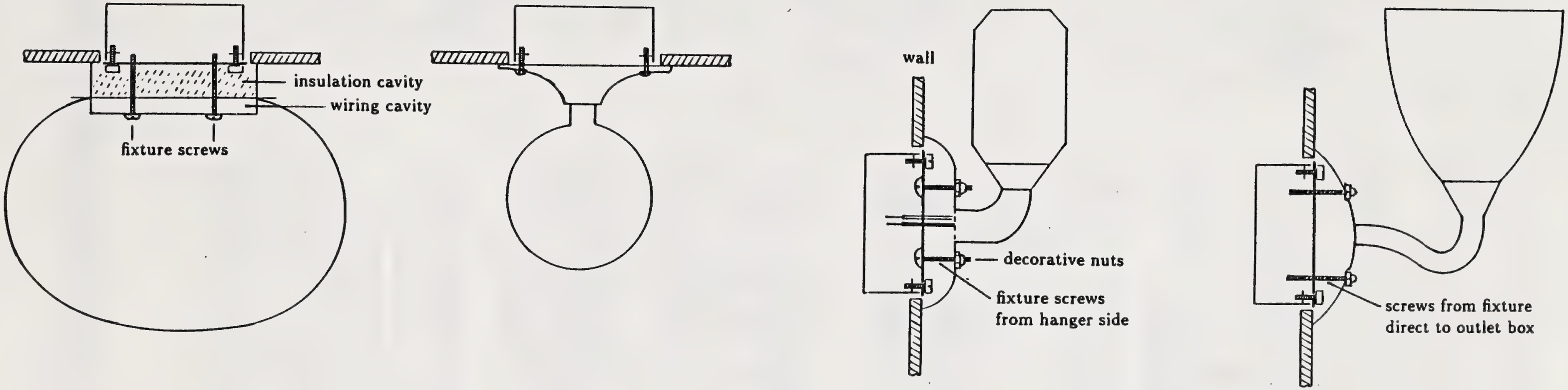


Stem-pendant central mount

Chain-pendant central mount

Cord-pendant central mount

Stem-pendant two-point mount


insulation cavity
wiring cavity
fixture screws
wall
decorative nuts
fixture screws from hanger side
screws from fixture direct to outlet box

Pan type two-point mount

Simple fixture direct connection two-point mount

Two-point wall mount

Two-point wall mount

Note: Connection details are presented in Appendix B

Figure 2.1: TYPES OF LIGHT FIXTURES

1. The raised flange aligns the plate with the outlet box.
2. The exterior flange flush mounts to building surface in the event that the outlet box is recessed or misaligned.
3. The outlet box side of the base plate has three wiring terminals to which the supply wires are connected.
4. A raised border around the terminals ensures proper positioning of the electrical contacts.
5. Four screw holes allow the base plate to be mounted in various orientations to standard outlet boxes.
6. The outer ring has two breaks to allow for proper mating with the attachment plate.
7. The mounting slots (19 in figure 2.3) are recessed to accomodate the head of fixture securing screws.
8. Fixture wires pass through the central aperture (20 in figure 2.3, which has a hexagonal nut profile surround that acts as a lock nut for centrally mounted fixtures.
9. The three wiring terminals are recessed to avoid interfering with the bayonet system and have a raised border (see 4).
10. The central cavity accommodates electrical wiring from the fixture (2 or 3 wires).
11. Six catches on the outer ring form the bayonet mechanism for mechanical connection. These catches have openings in the plate below to facilitate molding and stops 17 for alignment and structure.
12. Electrical contacts protrude through the central alignment rim 13 into the slots of the base plate (18 in figure 2.3 to provide electrical connections.
13. The central alignment rim fits between the contact housings on the base plate (18 in figure 2.3).
14. An arrow indicates the proper orientation for mating of the base and attachment plates (corresponding with 15 in figure 2.3).

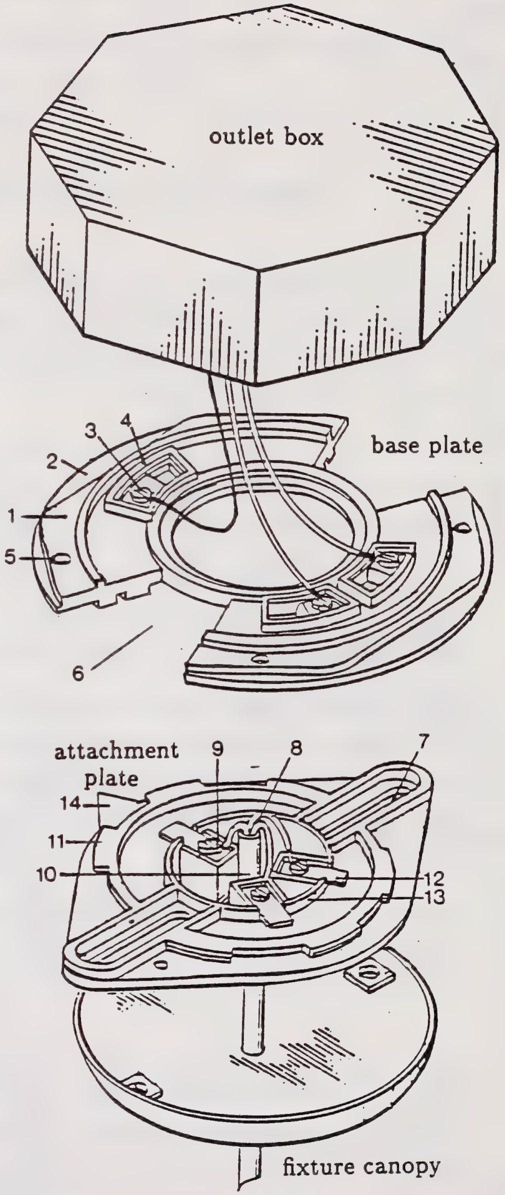
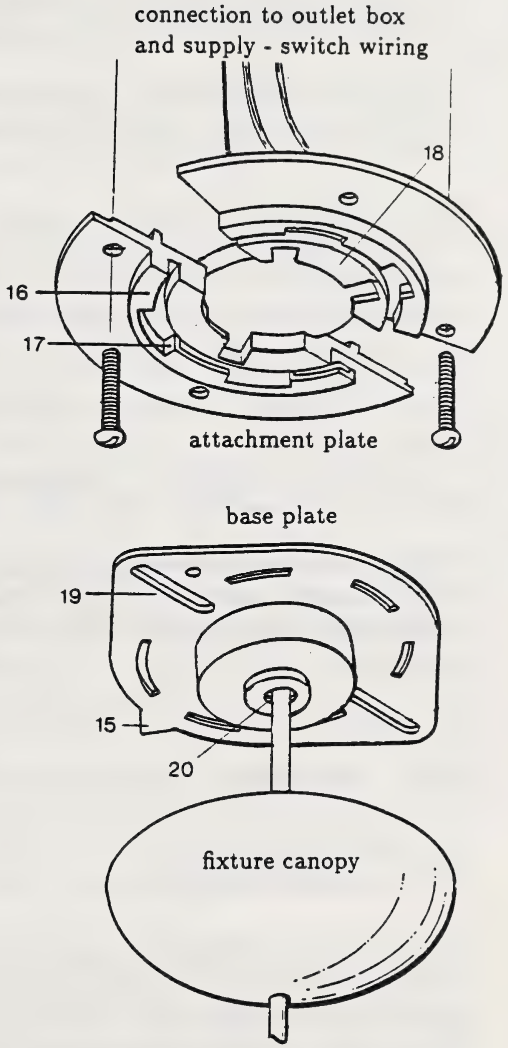


Figure 2.2: INITIAL DESIGN FEATURES: OUTLET BOX SIDE PERSPECTIVE



15. An alignment arrow corresponds with 14 in figure 2.2.
16. The outer ring has six catches for the bayonet mechanism. Openings in the plate below these catches facilitate moulding.
17. The bayonet catches 16 have a stop for alignment and structure.
18. The inner ring has three slots which accept male electrical contacts from the attachment plate. Correct polarity is ensured because the contacts are made in only one position.
19. The slots are used for securing two point mounted fixtures.
20. A central aperture is used to secure cord, chain and stem-pendant fixtures and for passage of fixture wiring.

Figure 2.3: INITIAL DESIGN FEATURES: FIXTURE SIDE PERSPECTIVE

plate. These J-shaped contacts are housed in three slots in the inner ring of the base plate (within 18 in Figure 2.3).

The electrical contacts of the ground are designed so that during removal or replacement of the light fixture, bonding is broken simultaneously with or after electrical contact is broken, and bonding is regained simultaneously with or before electrical contact is regained (UL 1571, 22.7).

Once wired, the base plate can act as a cover plate. The base plate electrical contacts are recessed (within 18 in Figure 2.3) to limit exposure of the live contacts (CSA C22.2-42, 4.1.5.14).

The metal parts are made of a copper alloy (CSA C22.2, 4.1.5.12). The Q.Lock connector was intended for injection moulding with a flame retardant, heat resistant, creep resistant, tensile polymeric material, such as Acrylonitrile Butadiene Styrene (ABS) (CSA C22.2-42, 4.1.3.1 3-5).

A rating of 120 volts / 300 watts was specified to cover the complete range of domestic fixtures. The maximum allowable weight for a light fixture mounted to an outlet box is 11.3 kg (25 lb) (CSA C22.2-9, 4.4.4). Thus, an 11.3 kg weight limit was proposed. There is ample space to mark these ratings and other required markings on the device (CSA C22.2-42, 6.1).

Design requirements, for elements such as contact heating under load, overload, endurance, dielectric strength, impedance, and security of conductor connections, were designed to meet the requirements for certified electrical receptacles.

2.3 Molded Prototype Evaluation

2.3.1 Introduction

In the process of constructing a prototype die, several design refinements were made. The major refinement to the initial design was a change in the base plate. The base plate cut-outs (6 in Figure 2.2) were filled in so as to provide a circular base plate that could act as a cover plate (Figures 2.4 and 2.5). This change was made to comply with CSA C22.2-18.

The change in the cut-outs required that the fixture mounting slots and associated raised border of the attachment plate (7 in Figure 2.2) be lowered with respect to the alignment rim which houses the terminals and provides an interior cavity for fixture wiring (13 and 10 respectively in Figure 2.2 compared with 13 and 10 in Figure 2.4).

The increased protrusion of the inner circular rim (13 in Figure 2.4) aids in the alignment of the respective plates when they are connected. The alignment rim corresponds with the circular groove (22) in the base plate (Figure 2.5).

The alignment arrows (14 in Figure 2.2 and 15 in Figure 2.3) were not considered necessary, and were not incorporated into the prototype mold.

In order to produce molded prototype castings, the injection molding procedure was optimized in terms of pressure (500 psi), temperature (420°F), injection time (3.5 seconds) and cycling time (20 seconds).

In order to produce high quality ABS and PVC castings, the mold was adjusted and polished to allow unassisted release of the castings.

At this point, the prototype castings were able to be fully tested. These tests revealed that fine tuning of the design was necessary. These refinements are discussed in the following sections.

2.3.2 Mechanical Connections

The molded prototypes had insufficient clearance to easily accommodate the light fixture wiring in the cavity between the terminal blocks of the attachment plate (10 in Figure 2.2). The terminal blocks were shortened (10 in Figure 2.4) to provide more clearance. This required that the electrical contacts be stepped (12 in Figure 2.4) rather than flat (12 in Figure 2.2). As well, apertures for the contact protrusion had to be deepened (underlying 12 in Figure 2.4).

The repositioning of the mounting slots (7 in Figure 2.4) on the attachment plate described previously (section 2.3.1), was made so that the base plate could act as a cover plate in accordance with certification requirements.

The mounting slots were lowered relative to the alignment rim (13 in Figure 2.4 compared with 13 in Figure 2.2). Thus, the alignment rim significantly protrudes above the slotted apertures. This protrusion, with corresponding groove in the base plate (22 in Figure 2.5), facilitates alignment of the base and attachment plates. Further, the top of the alignment rim is the height to which the rim of the fixture canopy should be set to achieve a close fit to the building surface.

To prevent the inadvertent removal of a light fixture, various ideas for a locking mechanism were considered. A pair of raised domes (23 in Figure 2.5) on the base plate are designed to ride over the ridge surrounding the mounting

1. The raised flange aligns the plate with the outlet box. With a spacer, the base plate can also be mounted directly to the building surface (European and Australasian approach).
2. The exterior flange flush mounts to building surface in the event that the outlet box is recessed or misaligned. The flange is continuous to act as a cover plate.
3. The outlet box side of the base plate has three wiring terminals to which the supply wires are connected.
4. A raised border around the terminals ensures proper positioning of the electrical contacts.
5. Four screw holes allow the base plate to be mounted in various orientations to standard outlet boxes.
6. The outer ring has two breaks to allow for proper mating with the attachment plate.
7. The mounting slots (19 in figure 2.5) are recessed to accomodate the head of fixture securing screws.
8. Fixture wires pass through the central aperture (20 in figure 2.5), which has a hexagonal nut profile surround that acts as a lock nut for centrally mounted fixtures.
9. The three wiring terminals are recessed to avoid interfering with the bayonet system and have a raised border (see 4).
10. The central cavity accommodates fixture wiring (2 or 3 wires).
11. Six catches on the outer ring form the bayonet mechanism for mechanical connection. These catches have openings in the plate below to facilitate molding and stops 17 for alignment and structure.
12. Electrical contacts protrude through the central alignment rim 13 into the slots of the base plate (18 in figure 2.5) to provide electrical connections.
13. The central alignment rim fits between the contact housings on the base plate (18 in figure 2.5) and corresponds with the circular groove 22 in figure 2.5.
14. The alignment arrow has been discarded.

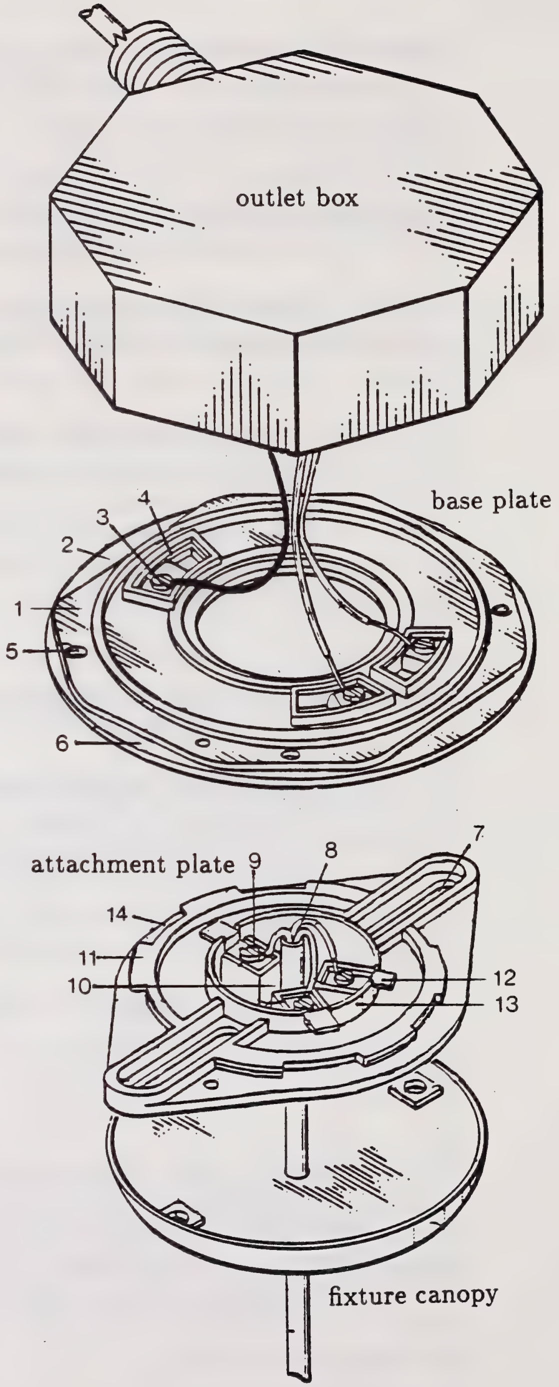


Figure 2.4: Q.LOCK CONNECTOR DESIGN FEATURES: OUTLET BOX SIDE PERSPECTIVE

15. The alignment arrow has been discarded.
16. The outer ring has six catches for the bayonet mechanism. Openings in the plate below these catches facilitate moulding.
17. The bayonet catches 16 have a stop for alignment and structure.
18. The inner ring has three slots which accept male electrical contacts from the attachment plate. Correct polarity is ensured because contact can be made in only one position.
19. The slots are used for securing two point mounted fixtures.
20. A central aperture is used to secure cord, chain and stem-pendant fixtures and for passage of fixture wiring.
21. The central cylinder on the light fixture side of the attachment plate can accommodate a friction fit spacer ring for fixture mounting.
22. Base plate alignment groove corresponds with the attachment plate alignment rim (13 in figure 2.3)
23. Raised domes ride over the slots of the attachment plate (7 in figure 2.3) to lock the plates together.
24. Housing for the sprung, J-shaped electrical contacts corresponding with the contacts 12 of the attachment plate.
25. A ground strap provides ground continuity for central and two point mounted fixtures.

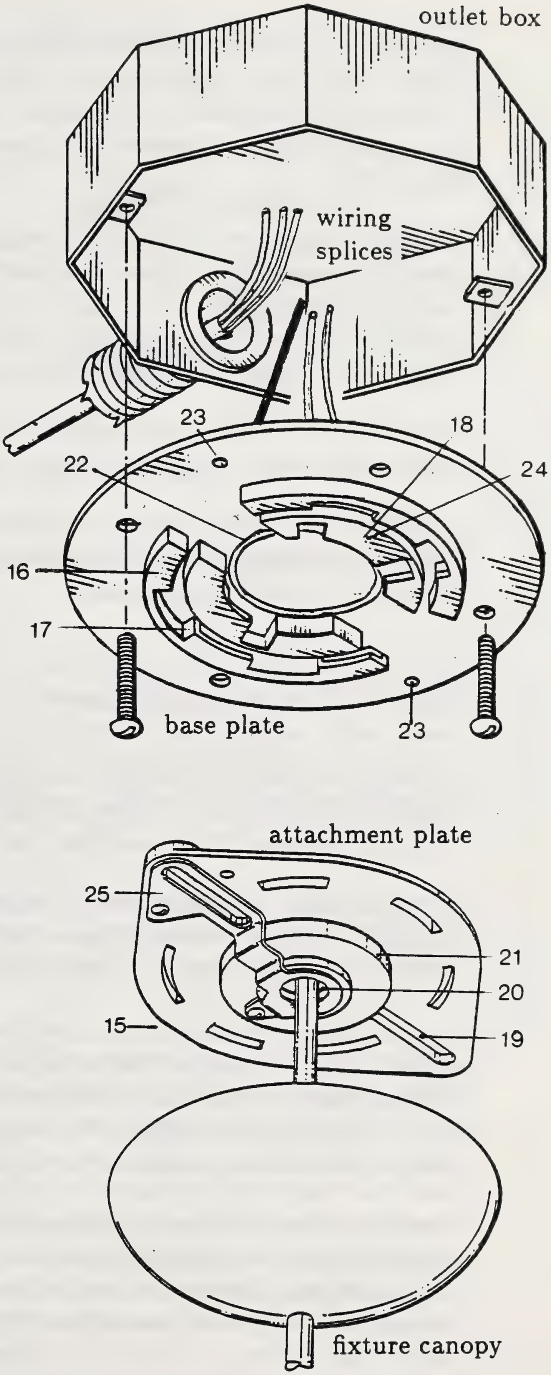


Figure 2.5: Q.LOCK CONNECTOR DESIGN FEATURES: FIXTURE SIDE PERSPECTIVE

slots (7 in Figure 2.4) as the attachment plate is rotated relative to the base plate. The domes come to rest in the mounting slots. Further clockwise movement is prevented by the catches and stops of the respective mechanical connectors of the base and attachment plates (11 in Figure 2.4 and 17 in Figure 2.5).

The dome height was initially set to minimize the thickness of the dome while providing reasonable resistance to inadvertent dislodgement. However, with prototype testing it was decided that greater resistance may be desirable. This was achieved by reboring the mold so as to produce a dome of greater height which would offer greater resistance to rotation.

To detach the plates, the attachment plate is rotated counterclockwise. A reasonable torque is required to move the protrusions over the ridges.

Although the locking domes do protrude into the mounting slots (7 in Figure 2.4), the domes do not interfere with the screws that secure the light fixture to the attachment plate.

2.3.3 Electrical Contacts

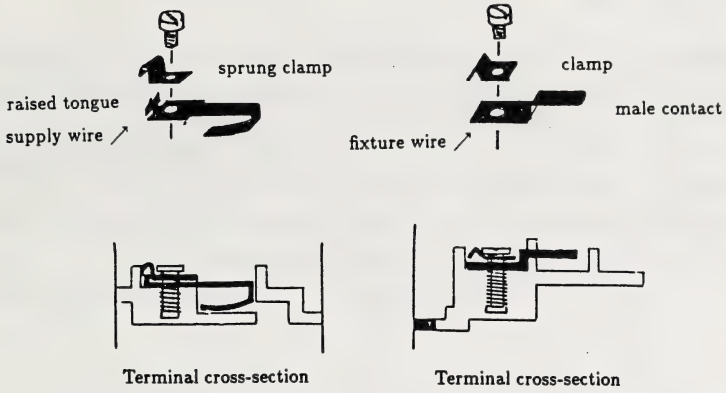
In the initial design of the Q.Lock connector, the electrical contacts of the attachment plate (12 in Figure 2.2) gouged the plastic wall of the base plate (18 in Figure 2.3). To correct this, the contact protrusion was shortened.

To more easily accommodate the wires from the light fixture, the molded terminal blocks of the attachment plate were lowered. As a result, a step was built into the electrical contacts (12 in Figure 2.5).

A quick wiring system was developed for single and multi-strand wiring. The conventional wrapping of the supply wiring around the terminal screw could be undertaken on the base plate terminals (CSA C22.2-42, 4.1.6). However, wire wrapping proved difficult for wiring the fixture to the attachment plate because of space limitations (9 in Figure 2.2).

Push-in connectors were developed in a trial and error manner in which components of varying configurations and metal characteristics were hand cut and folded. The push-in system was later discarded due to uncertainties in long term reliability (see section 3.2)

A two component hybrid system was then developed including the push-in feature in conjunction with a clamping feature (see also section 3.2.2). An upper clamp overlays the male contact of the attachment plate or J-shaped contact of the base plate (Figure 2.6). As illustrated in Figure 2.6b, the



(a) Attachment plate terminal

(b) Base plate terminal

Figure 2.6: PUSH-IN / CLAMP CONNECT SYSTEMS FOR THE Q.LOCK CONNECTOR

clamp and contact are screwed to the base plate. The J-shaped electrical contacts of the base plate are made of a spring copper alloy. The wiring terminal end of the J-contact has an undercut raised tongue. The raised tongue rotates slightly with the insertion of a single strand wire. The spring of the tongue acts to hold the electrical wire against the overlying clamp as the wire is pulled back.

For multi-strand fixture wiring, a simple inverted v-shaped clamp is secured by a screw through the clamp extension (Figure 2.6a). Multi-strand wire is connected by loosening the clamp, inserting the wire into the clamp, and re-tensioning the screw.

Experiments were undertaken in which the wiring terminals were secured by machine screws to a threaded metal insert in the plastic terminal block and by self tapping screws into the plastic terminal block. Although CSA C22.2-42, 4.1.6.4: 17 states that the 'Wiring terminal screws shall thread into metal', self tapping screws were investigated because of lower costs and ease of installation. Further, from discussions with CSA officials it was surmised that the terminals may be subject to the blade security test rather than the terminal parts section of standard No. 42. The blade security test states that the blade 'shall be capable of withstanding a direct force of 90 N (a mass of about 9 kg) for 2 min without loosening in the body or pulling out' (CSA C22.2-42, 7.2.1). Additionally, the self tapping screws could be inserted several times without affecting performance (UL 1571, 6.1). Thus, the die was modified so as to replace the 4.5 mm threaded metal insert terminal screw holes with a 2 mm hole for self tapping screws. A number of castings, which were produced in PVC and ABS, were redrilled to 4.5 mm so that the threaded metal inserts could also be tested. The remaining castings had the self tapping screw holes.

In-house testing of the Q.Lock connector was performed on the injection molded castings and electrical parts that were produced by a series of prototype dies. These tests suggested that PVC castings may distort under protracted heating. However, this was not a problem with the ABS castings. In all other respects, the prototype Q.Lock connector performed as designed. Given the satisfactory results of the in-house testing, the ABS casting model of the connector was submitted for regulatory approval.

Chapter 3

Regulatory Approval

3.1 Introduction

Regulatory approval through three agencies was undertaken:

1. Alberta Electrical Protection Branch (AEPB).
2. Canadian Standards Association (CSA), at two levels:
   i) 'Special Inspection' (a service offerred by CSA for low volume manufacturing); and
   ii) Full certification.
3. Underwriters Laboratories Incorporated (UL).

Approval by AEPB was sought so that the device could be tested and marketed in Alberta before certification. CSA certification is a requirement of the Canadian Electrical Code, and UL approval is similarly required by authorities in the United States.

A detailed description of the device, and quotations from or copies of the standards to which the Q.Lock was designed, were provided to the regulatory agencies, with summaries of in-house test results, sample products, and installation instructions (see Appendix B).

3.2 AEPB and CSA Special Inspection

A number of general concerns were raised by Alberta Electrical Protection Branch (AEPB) and in the Special Inspection by Canadian Standards Association (CSA). These items were in fact explicitly accommodated in the design, but two unforeseen problems were revealed in the inspections:

1. A grounding system that is independent of the light fixture was required or the connector could only be certified for use with explicitly grounded (three conductor) fixtures.

   Further, it was pointed out that any modifications to a certified canopy (e.g. addition of a ground wire) may void certification and any modification to a fixture would require re-certification of the fixture.

2. The push-in connectors may pose a problem in terms of reliability. Further, it was noted that terminals must be secured into metal, regardless of the results of the prototype development work.

3.2.1 Grounding

Given that very few fixtures have three conductors, it was imperative that an integral grounding system be designed to work with existing two conductor fixtures, otherwise the connector would have very limited applicability.

A ground strap was developed to provide ground continuity (see Figure 2.5 note 25). For luminaires with three electrical wires, the wires would be connected to the respective terminals of the attachment plate. For two wire luminaires, the hot (black) and neutral (white) wires are connected to the respective terminals. Grounding of a fixture with a conductive (metallic) canopy is achieved by contact with the ground strap, which in turn is connected to the ground terminal of the attachment plate.

For non-conductive (polymeric) fixture canopies, the ground strap is unnecessary, and only the positive and negative wires are connected to the attachment plate.

The base plate will always have the ground terminal connected to the outlet box ground screw because fixtures may have two or three wires and may have conductive or non-conductive canopies.

The attachment plate was designed to mount on existing light fixture canopies without modification of the canopy. In the future, manufacturers may wish to incorporate the Q.Lock connector directly into the fixture canopy. However, this would be the subject of an entirely separate request for certification.

3.2.2 Wiring Terminals

The attachment plate and base plate terminals were simplified as illustrated in Figure 2.6a. Single strand and multiple strand wire is secured by loosening the screw, inserting the wire into the clamp, and re-tensioning the screw.

For ease of compliance, it was decided that the terminal screws would be secured into a threaded metal insert rather than self tap into plastic.

Given that the design, and refinements described above, appeared to comply with regulatory requirements, the device was submitted for full CSA certification.

3.3 CSA Certification

In the CSA certification process, two shortcomings were revealed:

1. **Electrical Contacts:**
   It was shown that it was possible for the exposed live metal contacts of the base plate to be contacted with a probe tester (CSA C22.2-9, 4.4.4.4).

   The width of the J-shaped metal clips was reduced from 5.7 mm to 5.0 mm, and the product was successfully re-tested.

2. **Minimum Plastic Thickness:**
   CSA indicated that the minimum thickness of the base plate covering the electrical outlet box must be 2.5 mm.

   The central octagonal-shaped portion of the base plate, which covers the outlet box, was 2.5 mm. However, CSA indicated that the 2.5 mm minimum thickness also applies to the flange that extends beyond the outlet box (Figure 2.4, item 2). Therefore, the mold was modified to increase the thickness by a further 1.0 mm. (This provides greater rigidity to prevent distortion from overtightening).

Canadian Standards Association certification was obtained on January 10, 1990, as an "Incandescent Luminaire Hanger CSA Class 3426 01, Fixture and

Fitting - Fixture Fittings". The CSA certification label number is: LR 88272 (Appendix D).

The Q.Lock connector was certified as a generic hanger for a broad range of fixtures (two-point mounted fixtures, and stem-pendant, cord-pendant, and chain-pendant fixtures), with a rating of 300 watts, 120 volts, and a maximum fixture weight of 11.3 kg (25 lbs).

3.4 UL Certification

Underwriters Laboratories (UL) certification had to be undertaken through the UL western regional office in Santa Clara, California.

A comprehensive description of the relationship between the design features of the Q.Lock connector and UL standard 1571 (Incandescent Lighting Fixtures) was submitted to UL, as were copies of applicable CSA standards and the CSA Findings Letter. In addition, installation instructions and sample connectors were provided. (The installation instructions are attached as Appendix B).

Three concerns were raised by UL:

1. **Plastic Temperature Rating:**
   The ABS plastic used in the connector was rated for 60°C, whereas a temperature rating (125°C) was suggested by UL.

   Alternative plastics, such as Polyphenylene oxide (pphox), have been certified for use in outlet boxes by UL. Thus, UL considered pphox to be a suitable plastic for the connector.

2. **Earthquake Hazard:**
   Concern was expressed about the possibility of a fixture supported by the Q.Lock connector falling from a ceiling during an earthquake.

   The connector passed the CSA load test of 150 lb for 1 hour and was tested in-house to a 200 lb (89 kg) dynamic load (vertical and horizontal movement of a load attached to the connector), without failure. UL examined these test results and subsequently indicated that the connector did not appear to pose a hazard in an earthquake zone.

3. **Metal Hangers:**
   UL expressed a concern that it was possible that the plastic connector would melt during a house fire, thus creating the potential hazard of

a light fixture falling from a ceiling and striking a person, such as a fireman, on the head.

UL referred to the requirement that all hangers shall be made of metal (UL 1571, 36.9 'Mounting Means'), or shall carry a weight less than 2 pounds (0.91 kg) (UL 1571, 56.10).

Two arguments were raised over the UL position.

1. Under Exception No. 2 of UL 1571, 36.9:

   "If a crossbar of lesser thickness is investigated and found able to support four times the weight of the fixture without any visible distortion, there is no minimum thickness required."

   The intent of the UL requirement is clearly met by the connector as shown by the CSA test results. The connector passed the CSA test of a one hour steady pull of six times the total mass supported (25 lbs) (CSA C22.2-9, 6.14).

2. Plastic electrical outlet boxes have been certified by UL (UL 514C) to hold light fixtures up to 25 pounds in weight.

   Given that plastic outlet boxes are certified for use, UL indicated that it could be perceived as unreasonable that a suitable plastic hanger could not be used to support a fixture when a plastic box can be used.

UL's Fire Protection section was asked to establish criteria for testing the connector in view of the certified use of plastic outlet boxes.

UL subsequently indicated that since National Electrical Manufacturer's Association tests showed that plastic outlet boxes satisfactorily withstood test fires, the Q.Lock connector is also qualified for use as a light fixture hanger.

The UL findings letter (Appendix D) contained three significant comments:

1. Prevention of inadvertent dislodgement of the attachment plate from the base plate cannot rely on friction between the surfaces (UL 1571, 23.18). The raised dome lock fulfills this requirement.
2. UL is in the process of deleting the requirement for the exclusive use of metal hangers.
3. Requirements for polymeric materials have been specified. These are not significantly different than requirements specified by Canadian Standards Association.

Chapter 4

Cost Analysis and Markets

4.1 Costs

Manufactured and end-user costs of the Q.Lock connector were estimated on the basis of prototype production data, expected production processes, and other factors.

For the CSA-approved ABS casting, the Q.Lock connector has an estimated low volume production cost from $1.04 to $1.16 Cdn. Details are provided in Table 4.1.

The lower price applies for non-conductive fixture canopies where a ground is not required and the latter applies to grounded fixtures. In either case the base plate would be grounded, but the attachment plate may or may not have a ground depending on the type of fixture.

Table 4.1: LOW VOLUME MANUFACTURING COSTS OF THE Q.LOCK CONNECTOR

Item	Base Plate	Attachment Plate	Comments
Molding	5 c	5 c	8 cavity mold, 4 connectors
ABS casting	18 c	15 c	62 g at $5.00 per kg
Electrical contacts	12 c	12[a] - 18 c[b]	[a] non-conductive canopy [b] conductive canopy
Threaded metal inserts	9 c	6[a] - 9 c[b]	[a] [b] as above
Assembly	12 c	10[a] - 15 c[b]	manual placement power installation
Total	56 c	48[a] - 60 c[b]	Sum: $1.04 - $1.16 Cdn.

Significant savings could be achieved through high volume production. For example, bulk purchasing of ABS material would reduce the plastic cost by half. Similar cost reductions would also occur for the other components which are priced for low volume contract manufacturing. Costs for other polymeric materials, such as Polyphenylene oxide (pphox), are similar to ABS.

For bulk shipment to manufacturers, packaging would be a minimal expense on a per unit basis. However, packaging would be necessary for the retrofit market. Costs would be about 15 to 25 cents per unit for shrink and blister packages, respectively, for low volume purchasing of packaging. Costs could be significantly reduced by self-manufacture of the packaging, or through bulk point of sale display of the connector similar to the manner in which receptacles and switches are displayed in retail outlets.

Typically this type of product has a final retail price of 3 to 4 times the manufacturing cost. Thus, the retail price would be $3.12 to $4.64 for low volume production.

4.2 Markets

New home construction statistics, domestic light fixture manufacturing statistics, and import statistics indicate that the potential market is 30 to 75 million units per year for Canada and the United States. Of this, the potential new home market is conservatively estimated at over 25 million units annually, with the remaining market in the retrofit area. About one tenth of the market is in Canada.

The device has been designed to be compatible with requirements in other areas of the world, such as Europe. Pro-rating by population of highly developed countries, the world market is conservatively estimated at 100 to 300 million units annually.

There is no known competition for the device, and extensive patent protection has been granted (e.g. United States patent 4,929,187 issued May 29, 1990).

The company plans to form a partnership to manufacture and distribute the Q.Lock connector, with an initial focus on North America.

Chapter 5

Demonstration

5.1 Introduction

A representative array of residential lighting fixtures, encompassing a range of weights, lamp configurations, bulk, and wattage, was selected and obtained for demonstration purposes (Table 5.1).

Table 5.1: DEMONSTRATION LIGHT FIXTURES

Style	Weight (g)	Watts	Comments
2-Point Mount:			
Simple canopy	1850	300	bulky, leaded glass
Pan type	785	60	thick pan, glass globe
Special 2-Point	225	100	lugs installed
Stem-Pendant	220	75	single stem, glass globe
Cord-Pendant	175	150	no shade
Chain-Pendant	150	100	no shade

Fixture types are illustrated in Figure 2.1 on page 5. 'Special 2-point fixtures', in Table 5.1, refer to fixtures for which a special mounting lug was installed. This mounting lug would normally be spot welded or riveted to the canopy at a height appropriate for the direct connection of the attachment plate. These mounting lugs were added to a fixture to emulate manufacturer installed mounting lugs.

In conventional installations, the light fixture is mounted to a hanger bar that is screwed to the outlet box. In the case of pendant style fixtures, the central threaded aperture is used as a port for the wiring and as the mounting point. The stem is screwed into the threaded hanger bar and electrical connections are made to the supply wires. For cord-pendants, the cord goes through the central aperture of the hanger bar and is held with a retainer. The canopies (or covers) generally slide up the stem (or cord) and are held in place by a locking screw.

In the case of two-point mounted fixtures, the hanger bar is first secured to the outlet-box and the wiring connections are made to the fixture before the fixture is secured. For pan type fixtures, screws are inserted from the lampholder side through the fixture into the hanger bar. The screws must align with threaded screw holes in the hanger bar. For other two-point mount canopies, the screws may first be secured to the hanger bar, after which the fixture is wired and placed over the outlet box. The screws project through the canopy and the fixture is secured to the screws with decorative nuts. Once the fixture is in place, the screws may have to be cut to length.

5.2 Installation Trials

An individual deemed to be representative of the average homeowner, with no specialized skills in electrical work, carried out the demonstration work. In addition, the author undertook comparative demonstrations. The time trial results are listed as 'novice' and 'expert', respectively.

Each fixture was installed first in the conventional manner (connection to a metal hanger on the outlet box), then using the Q.Lock connector. In each case, the time taken to complete the task was recorded. As well, a photographic record is presented in Appendix C.

In each case, all the required tools and hardware were collected and conveniently placed so as to measure the time required to undertake the installation task. No specialized tools were required. The hardware supplied with the fixtures was used in the tests. The demonstration results are summarized in Table 5.2.

The Q.Lock system has two components: a base plate and an attachment plate. The base plate is wired to the household supply and switch wires and mounted on wall or ceiling electrical outlet boxs. The attachment plate is wired and attached to the light fixture.

Base plate installation has three elements: addition of a ground wire to the outlet box ground screw; connection of supply wiring to the base plate terminals; and securing of the base plate to the outlet box. For wall installation, the times required (in minutes and seconds) were 0:32, 0:46 and 0:46, respectively, for an elapsed time of 2 minutes and 4 seconds (2:04). An elapsed time of three minutes was required for a ceiling base plate installation.

Table 5.2: INSTALLATION TIMES FOR SELECTED FIXTURES

Style	Conventional (min.:sec)	Q.Lock Novice	Q.Lock Expert
2-Point Mounted Fixtures:			
Simple canopy	> 30 min	3:35 (min: sec)	2:07 (min: sec)
Pan type	> 30 min	-	3:55
Special Fixtures	na	1:47	1:06
Stem-Pendant Fixture	6:26 #	2:14	2:06
Cord-Pendant Fixture	2:34	1:50	1:47
Chain-Pendant Fixture	2:34	2:22	2:06

Note: the base plate took 2:04 to install on a wall and 3:00 on a ceiling- these times should be added to the Q.Lock times for a complete first-time installation;
# indicates it was not possible to install the fixture with the hardware provided;
na indicates non-applicability.

As indicated in Table 5.2, the time required to install fixtures varies greatly as a function of fixture configuration.

5.3 Discussion

As indicated previously, the hardware supplied with the fixtures was used in the timing tests for conventional installations. In some cases, particularly for the two-point mounted fixtures, it should be noted that it is very difficult to align the fixture so that screws can be inserted through the canopy (and through the insulation blanket in the case of pan type fixtures), into the appropriate threaded screw hole of the hanger bar. In these cases, the installation was abandoned after thirty (30) minutes.

In the case of the wall mounted fixture, it was not possible to correctly install the fixture with the hardware provided. For the fixture to be properly oriented, the electrical outlet box would have to be 45 degrees from the normal horizontal position. If the box is oriented thus: ◇, the single bar hanger is horizontal (or vertical) and thus correctly positioned for the screws from the canopy. However, the ◇ box alignment is not normal practice. A second horizontal hanger bar had to be attached to the first hanger so that the fixture could be installed correctly. The cross bar and fixture installation process took several minutes.

The connector system was not able to be used with two fixtures: simple plastic lampholders that have an extended base which serves both to mount the fixture and to cover the outlet box; and shallow pan fixtures (less than 15 mm deep). The former type of fixture is commonly used in low aesthetic environments, such as garages and unfinished basements. It should be noted that this type of fixture is amenable to being molded with the attachment plate in place.

The above testing focused on installation times. The results show that very significant time savings can be obtained by using the Q.Lock system. In addition, in some circumstances, the time required to remove a fixture may also be an important factor. Removal times for conventionally mounted fixtures ranged from 27 seconds for a cord-pendant fixture to 3 minutes and 15 seconds for a two-point wall mounted fixture. Once a fixture has been fitted with a Q.Lock connector, it can be removed and re-installed in a matter of seconds.

Chapter 6

Benefits

6.1 Effectiveness

Based on information derived from the demonstration, estimates of the effectiveness of the Q.Lock connector were made. A specific example was used to demonstrate time savings with use of the Q.Lock connector.

Nine fixtures were fitted with the Q.Lock system in a demonstration house. The remaining fixtures in the house (pot lights, track lighting, fluorescent lighting and miscellaneous lamps) are not presently suitable for use with the Q.Lock system.

From Table 6.1, it is quite clear that significant time savings may be achieved with the application of the Q.Lock connector system. The total time required strictly for installation for nine fixtures in the demonstration application was 3 hours and 15 minutes for the conventional system and less than 45 minutes for the Q.Lock system including base plates installations and fitting of the attachment plates to the light fixtures. If the attachment plates were installed by the manufacturer or retailer (which is expected in the future), the total installation time using the Q.Lock system would be reduced to about 20 minutes in the example application.

6.2 Benefits to Homeowners

There are three major advantages for the homeowner:

1. The cost of installation of light fixtures should decrease quite significantly. In the example application, the estimated labour costs are $146.00 for a conventional system compared to $34.00

Table 6.1: INSTALLATION TIMES FOR NINE LIGHT FIXTURES

Location	Style	Conventional	Q.Lock	Difference
Entrance	Wall stem-pend.	6:26 *	4:08	2:18
Dining room	ceiling 2-point	>30 min	5:37	~ 30 min
Lounge	cord-pendant	2:34	3:51	+ 1:17
Hall	ceiling 2-point	>30 min	6:19	~ 30 min
Hall	ceiling 2-point	>30 min	6:19	~ 30 min
Bathroom	shallow pan type	>30 min	na †	pan too shallow
Bedroom	ceiling pan type	>30 min	6:50	~ 30 min
Bedroom	ceiling pan type	>30 min	6:50	~ 30 min
Bedroom	ceiling 2-point	6:40	6:35	0:05
Total time:		> 195:40	44:29	~ 2.5 hours

Note: * indicates it was not possible to install the fixture with the hardware provided;
† it would take about 7 minutes to conventionally install a standard pan type fixture in this instance.

or $15.00 for the Q.Lock system. In the latter case, the fixtures would be purchased with the Q.Lock system in place. These figures are based on a typical charge-out rate of $45.00 per hour.

The actual savings to the homeowner would vary with the number and type of fixtures in a house and would depend on how much of the labour savings would be passed on by the electrical contractor. For example, if all the installations were cord-pendants, then there would be a net increase in costs to the homeowner- but this is improbable. On the other hand, the installation of numerous standard pan type and two-point mounted fixtures would result in even greater savings to the homeowner.

2. Future fixture upgrades or replacements with the Q.Lock system will be within the capability of most homeowners. Presently, a permit is required to install new or replacement fixtures. Frequently the permit acquisition and installation are undertaken by an electrician at fairly considerable cost (travel time, and labour for the installation, plus permit fees). With the Q.Lock system in place, replacing a fixture will be analagous to plugging in an electric toaster.

3. Subsequent maintenance, such as fixture cleaning or removal for maintenance, will be easily and safely undertaken by the homeowner.

A disadvantage to the homeowner is that light fixtures may increase slightly in unit cost. However, two points should be borne in mind: (1) the Q.Lock system will replace some existing hardware; and (2) the hardware costs are generally very small relative to the cost of fixtures the Q.Lock system will replace some existing hardware; and (2) the hardware costs are generally very small relative to the cost of fixtures or the cost of installation.

6.3 Benefits to Electrical Contractors

The advantages to electrical contractors include:

1. The cost of installation for the contractor would decrease significantly. In the example application the costs would decrease from $49.00 to $11.00. This is based on an assumed wage payment of $15.00 per hour. When the Q.Lock system is pre-fitted by the manufacturer or retailer, the labour costs to the electrical contractor would decrease even more (to less than $5.00 in the example application).
2. There will be a competitive advantage for contractors adopting the Q.Lock system. This advantage could at times be crucial in that many bids are won or lost on the basis of a few dollars.
3. Contracting quotations could be more accurate. When fixtures with the Q.Lock system are purchased, the installation time is known to be 2 to 3 minutes per fixture, rather than some highly variable "average" installation time.
4. Back-ordered fixtures will not present a significant problem. The base plate would be installed by the electrical contractor and the fixture could be "plugged in" by the home owner when it became available.

6.4 Benefits to Builders

The Q.Lock connector would facilitate earlier completion of the wiring for new home construction. Lighting fixture base plates could be installed immediately after drywall is installed. Temporary lampholders with integrally molded attachment plates could be used as required to facilitate inside finishing, and could be removed for re-use at other construction sites when the final fixtures are installed.

The device would also be an effective marketing tool. For example, it would be very easy to install alternative lighting fixtures in order to close a sale that might otherwise be lost, and subtrade cost would not be incurred in the process.

6.5 Benefits to Fixture Manufacturers

Manufacturers are expected to accept and adopt a universal design for a quick fit light fixture device (in a manner analagous to the acceptance of the audio cassette design or VHS video system) because it provides two major advantages:

1. an increased market share for manufacturers who adopt a common, universal, inexpensive, easily incorporated, superior technology; and
2. increased market volume, because the ease of installation and removal of light fixtures would decrease customer reluctance to purchase new light fixtures (e.g. renters and home owners who would not normally change existing fixtures).

Chapter 7

Conclusions

The Q.Lock light fixture connector represents a step forward in technology for the benefit of the housing industry and all parties involved, from the manufacturer through to the consumer. The work in this project has demonstrated three major characteristics inherent in the Q.Lock connector and necessary for success in the marketplace - convenience, safety and affordability.

Convenience

Installation and removal of lighting fixtures fitted with the Q.Lock connector are minor and easy tasks. This represents a tremendous benefit to the homeowner for such jobs as cleaning, maintenance, and replacement of fixtures. Convenience of installation and replacement also represents significant benefits to the electrical subtrade and the builder for both new construction and renovations.

Safety

The Q.Lock was designed and certified in accordance with stringent technical standards. The primary focus of those standards is the safety of the end user. Installation and removal of light fixtures can be undertaken without risk and without the requirement for specialized skills, and the potential for incorrect wiring in retrofit and renovation works can be eliminated.

Affordability

The Q.Lock connector can be made available to the retail user for $3 to $5 Cdn. In the overall scale of home accessory products, this represents a very small investment. Its potential for future savings once installed makes it an extremely attractive investment for the electrician and builder as well as for the homeowner. Manufacturers can incorporate the Q.Lock connector into lighting fixtures and open up entirely new avenues in the marketing of their products.

The device has been designed to be compatible with requirements in other areas of the world, such as Europe. Pro-rating by population of highly developed countries, the world market is conservatively estimated at 100 to 300 million units annually.

There is no known competition for the device, and extensive patent protection has been granted (e.g. United States patent 4,929,187 issued May 29, 1990).

The degree of market penetration is difficult to judge. However, given the benefits to the homeowner, electrical contractor, fixture manufacturers and retailers, as well as builders, it is expected that the Q.Lock system will become an accepted commodity in the housing industry marketplace.

Appendix A

Governing Standards

Canadian Standards Association (CSA) Standard C22.2 No. 0-M1982. General Requirements - Canadian Electrical Code. November, 1984.

Canadian Standards Association (CSA) Standard C22.2 No. 0.4-M1982. Bonding and Grounding of Electrical Equipment.

Canadian Standards Association (CSA) Standard C22.2 No. 9-1968. Electrical Lighting Fixtures.

Canadian Standards Association (CSA) Standard C22.2 No. 18-M1981. Outlet Boxes, Conduit Boxes and Fittings. August, 1984.

Canadian Standards Association (CSA) Standard C22.2 No. 42-M1984. General Use Receptacles, Attachment Plugs, and Similar Wiring Devices. February, 1987.

Underwriters Laboratories UL 514C. Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers. June 13, 1989.

Underwriters Laboratories UL 746C. Polymeric Materials- Use In Electrical Equipment Evaluations. March 6, 1990.

Underwriters Laboratories UL 1571. Incandescent Lighting Fixtures. July 27, 1989.

Appendix B

Installation Instructions

Preface

The following Installation Instructions were submitted to Underwriters Laboratories. There are two objectives for appending this material:

1. to illustrate the type of documentation sent to regulatory agencies to support the request for certification; and
2. to provide a more detailed description of the Q.Lock connector to aid the reader in understanding how the connector works.

Throughout this text reference is made to Underwriters Laboratories Standards UL 1571 Incandescent Lighting Fixtures, July 27, 1989. In addition, the text in italics are not part of the installation instructions, but represents points of discussion with UL regarding approval conditions.

B.1 Introduction

The Q.Lock Connector is a device which permits the easy installation and removal of surface mount, interior, incandescent light fixtures to wall or ceiling electrical outlet boxes.

There are two components to the light fixture coupling device:

- a *base plate* which is wired and mounted on to an electrical outlet box, and
- an *attachment plate* to which to light fixture is attached.

It is intended that an electrician will install the base plate in homes as a matter of course in the same way that electricians currently install receptacles. The home owner, or electrician, will then purchase light fixtures with an attachment plate already mounted at the factory. The installer merely has to connect the light fixture to the base plate in a manner analagous to plugging in an electric toaster. However, it is recognised that a significant retrofit market (for application to existing fixtures) also exists. This description is more focused toward these applications.

In the following sections, the mounting of the base plate is described. Then the mounting of light fixtures to the attachment plate is described for several types of light fixtures.

B.2 Base Plate

To mount a light fixture, the 'base plate' is first wired and then mounted on the electrical outlet box. The following steps are followed

1. The supply wires (black, white, and ground) from the outlet box are connected to the terminal clamps of the base plate (Figure 1A) (Sections 23.17, 23.32 and 33.10). These base plate terminals are marked B, W, and G, respectively (Section 33.10).

   The connections are made by loosening the clamp on the terminals and slipping the appropriate electrical wire into the clamp. The length of exposed wire (wire with the insulation removed) should be slightly longer than the width of the cable clamp. Once the wires are inserted into the cable clamp, the clamp screws are retightened.
2. In Figure 1B the mounting of the base plate of the Q.Lock Connector to the electrical outlet box is shown. The screws from the outlet box are used to mount the base plate to the outlet box.

Position the base plate against the electrical outlet box and align the holes on the base plate with the screw holes on the outlet box. Insert the screws through the base plate holes, and tighten the screws.

- If the outlet box is flush with, or extends beyond, the wall or ceiling finish, the base plate is easily aligned because of the built in positioning plate (the raised octagonal portion of the base plate shown in Figure 1A).
- The flange around the base plate will flush mount to the building surface in the event that the outlet box is within the building surface, or is misaligned with respect to the building surface.
- The base plate has a preferred orientation for some fixtures. The arrow on the base plate should be mounted so as to be at the top of the outlet box in a wall mounted installation (Section 32.2). A similar arrow would indicate the orientation of the attachment plate with respect to the light fixture.[1]

At this point the base plate may be left to act as a cover plate, or a light fixture may be mounted. If the light fixture has a factory installed attachment plate, then proceed with assembly as described previously. If the attachment plate has to be fitted to the light fixture, the section on mounting of light fixtures should be consulted.

Connections may be easily inspected (Sections 23.5, 23.7), and the base plate does not protrude significantly into the outlet box, thus complying with the free space requirements for fixture leads (Section 23.8).

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[1] Author's note: in the final design, the alignment arrow was discarded.

Figure 1. Connection of the base plate to the outlet box and supply wires

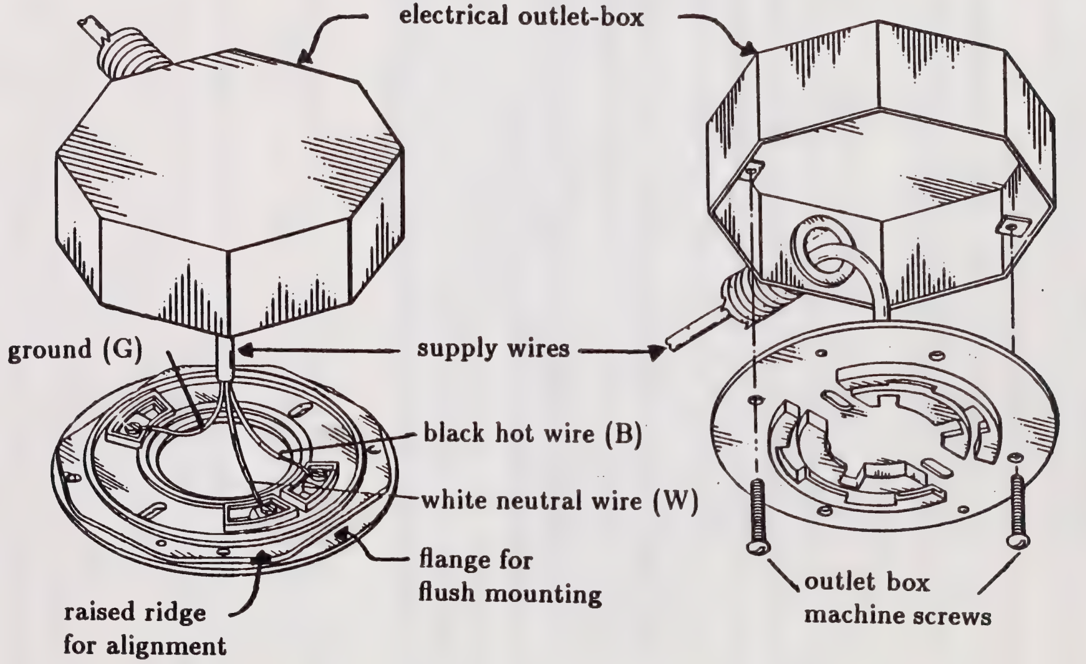


Figure 1A: Details of the electrical connections

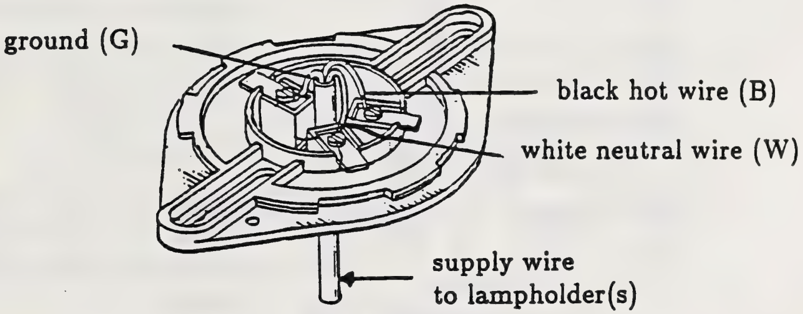
Figure 1B: Details of the mechanical connections

B.3 Mounting Of Light Fixtures

Several types, or styles, of pendant and two-point surface mounted (Section 2.20), incandescent, light fixtures may be mounted on an attachment plate (Section 36.12, part D). The mounting of each of these types of fixtures is discussed.

The supply wires from the fixture shall terminate at the terminals of the attachment plate (Figure 2A). In some instances it would be advantageous for these wires to be less than the 6 inch length specified in Section 23.4. *Do Underwriters feel that it would be permissible to state in the installation instructions that the wires may be trimmed to a shorter length so that they may more easily fit into the space provided?* (Author's note: this was not contested by UL).

Figure 2A: Attachment plate electrical wiring

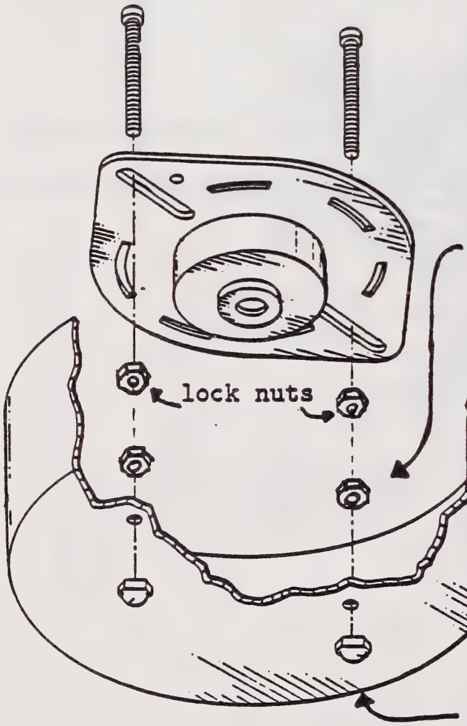


B.3.1 Two-Point Mounted Fixtures

A two-point mounted light fixture is mounted on the attachment plate by means of a pair of machine screws inserted through the attachment plate and secured by means of lock nuts, spacer nuts and decorative nuts. The height of the canopy is determined by adjustment of spacer nuts, as illustrated in Figure 2B. The screws are maintained in a correct width position within the slots of the attachment plate with the lock nuts. The canopy is secured by the decorative nuts.

In a manufacturer adapted light fixture, mounting lugs are provided at the appropriate height. The fixture is secured to the attachment plate with screws that self-tap into the mounting lug. Under the exception, fixtures in excess of 7-1/2 pounds can be attached in this manner if the construction is investigated and found to be the equivalent of other acceptable fastening means (Section 6.2). (However, in this event the manufacturer would seek separate UL approval of this application for the light fixture).

Figure 2B: Installation of two-point type fixture



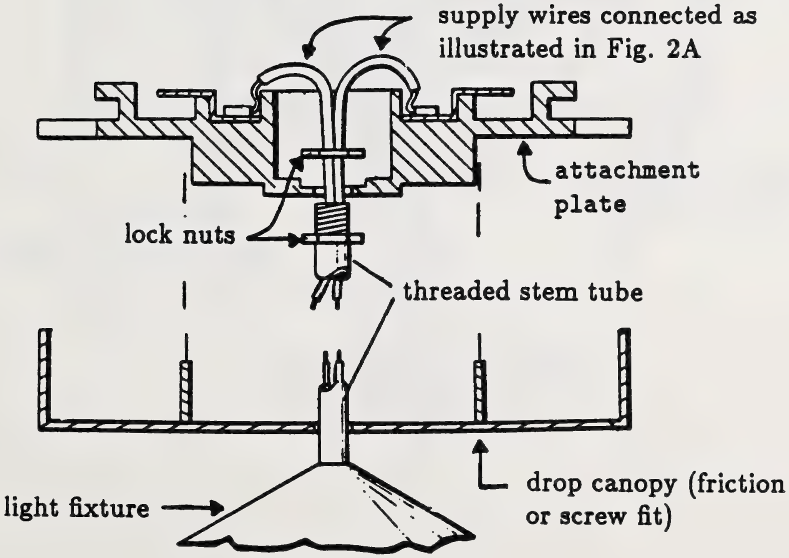
1. Screws set to correct width and secured in place with lock nuts (align with holes in the canopy)
2. Spacer nuts set to correct height (so that the canopy is flush with the building surface)
3. Screws are cut to correct length (if necessary)
4. Canopy secured in place with decorative nuts

B.3.2 Stem-Pendant Fixtures

Stem-pendant fixtures (Sections 2.12, 60.6) with a single threaded tube (or conduit) are secured as follows:

1. The tube is inserted through the central hole of the attachment plate, and lock nuts are used to secure the tube to the attachment plate (Figure 3).
2. The electrical wiring of the light fixture runs through the tube. The wiring is connected as described in Figures 2A and 3.
3. Once the fixture is secured and wired to the attachment plate, connection to the wall or ceiling base plate may be made as described earlier.
4. To complete the installation, a drop canopy (Section 2.3) is secured by a friction fit to the attachment plate (as illustrated in Figures 3 and 4) or by means of a horizontal screw from the canopy to the stem.

Figure 3: Stem-pendant fixture

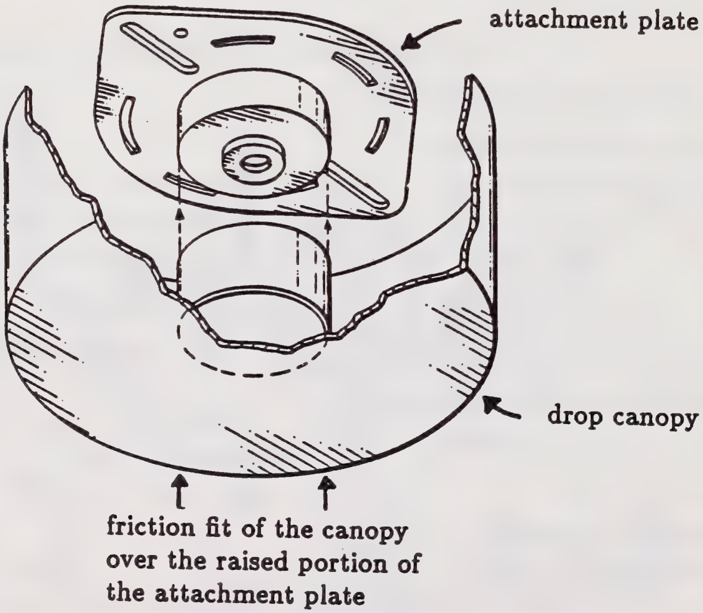

supply wires connected as illustrated in Fig. 2A
attachment plate
lock nuts
threaded stem tube
drop canopy (friction or screw fit)
light fixture

B.3.3 Cord-Pendant Fixtures

In this application a flexible electrical cord extends from a lamp shade through the central hole in the attachment plate. A strain relief device (Section 2.19) is positioned along the electrical cord to adjust the height of the lamp. About 5 cm (2 inches) of wire is left to make the electrical connections as described in Figure 2A. A drop canopy may be mounted on the attachment plate by friction fit as shown in Figure 4.

The strain relief device would comply with Sections 24 or 37.6 and 38.17.

Figure 4: Friction fit of a drop canopy

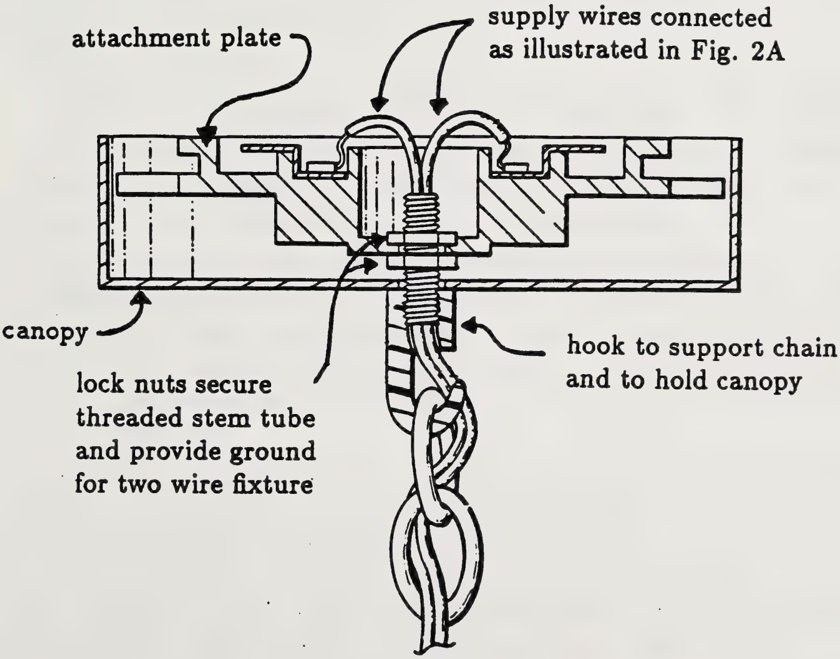

attachment plate
drop canopy
friction fit of the canopy over the raised portion of the attachment plate

B.3.4 Chain-Pendant Fixture

Chain-pendant fixtures have chain links through which the electrical wires are twined. The chain links are hung onto a hook which is secured to the attachment plate by a threaded rod and lock nuts (Figure 5A). The supply wires enter the attachment plate through the hook and threaded tubular rod. Electrical connections are made as described in Figure 2A. The canopy is secured flush to the building surface by the hook as illustrated in Figure 5A.

The stranded supply wires are so arranged that the weight of the fixture is transferred to the hook rather than to the conductors (Section 37.10).

Figure 5: Chain-pendant fixture


attachment plate
supply wires connected as illustrated in Fig. 2A
canopy
lock nuts secure threaded stem tube and provide ground for two wire fixture
hook to support chain and to hold canopy

B.3.5 Integrally Moulded Fixtures

The attachment plate may be directly injection molded with a lamp fixture base to produce an integral (or one piece) unit. In this application, only the central portion of the attachment plate is utilized. The elongated recess or 'wings' of the attachment plate are not necessary. Also, the electrical cord is substituted with a direct electrical connection from the terminals to the lampholder(s). This device will be submitted separately for approval.

Appendix C

Photographs

To mount a light fixture, the 'base plate' is first wired and then mounted on the electrical outlet box. The supply and switch wires (hot: black; white: neutral; and ground) from the outlet box are connected to the terminal clamps of the base plate (Figure C.1). These base plate terminals are marked B, W and G to indicate the black, white and ground supply wires.

The connections are made by loosening the clamp on the terminals and slipping the appropriate conductor into the clamp. The length of exposed wire (wire with the insulation removed) should be slightly longer than the width of the cable clamp. Once the wires are inserted into the cable clamp, the clamp screws are retightened.

To mount the base plate, the plate is positioned against the electrical outlet box and the holes on the base plate are aligned with the screw holes on the outlet box (Figures C.1 and C.2). The screws are inserted through the base plate holes, to the threaded outlet box lugs and tightened. The screws from the outlet box are used to mount the base plate to the outlet box.

If the outlet box is flush with, or extends beyond, the wall or ceiling finish, the base plate is easily aligned because of the built in positioning plate (the raised octagonal portion of the base plate).

The flange around the base plate will flush mount to the building surface in the event that the outlet box is within the building surface, or is misaligned with respect to the building surface (Figure C.2)

The base plate has a preferred orientation for some fixtures. The base plate should be mounted so that the grounded terminal points downward in a wall mounted installation (Figures C.1 and C.2).

At this point the base plate may be left to act as a cover plate (Figure C.1), or a light fixture may be mounted. The ease of removal or installation of a fixture with an appropriate attachment plate will

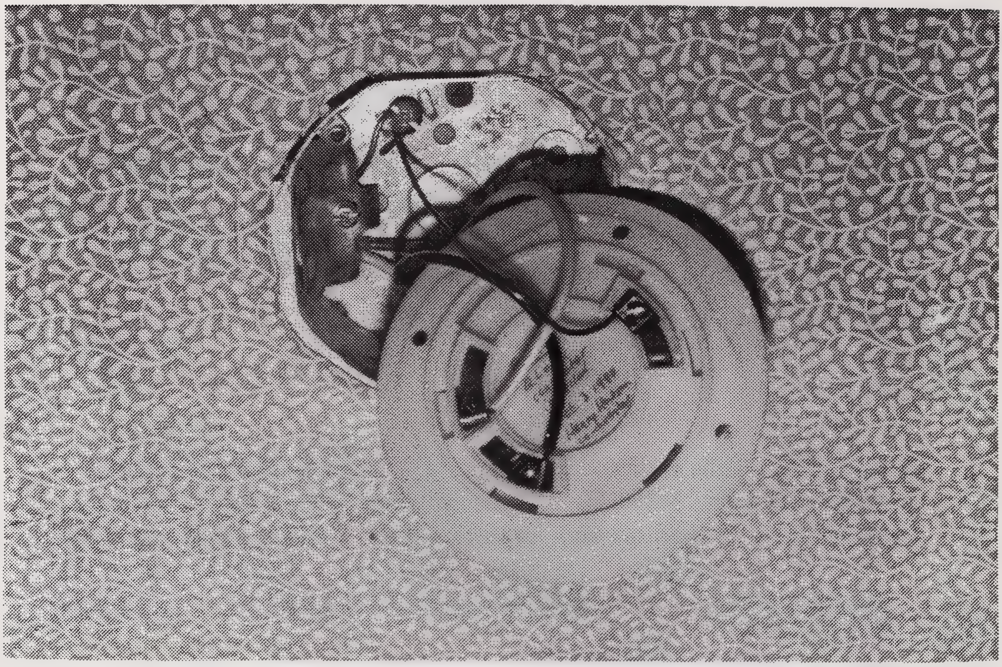


Figure C.1: BASE PLATE WIRING

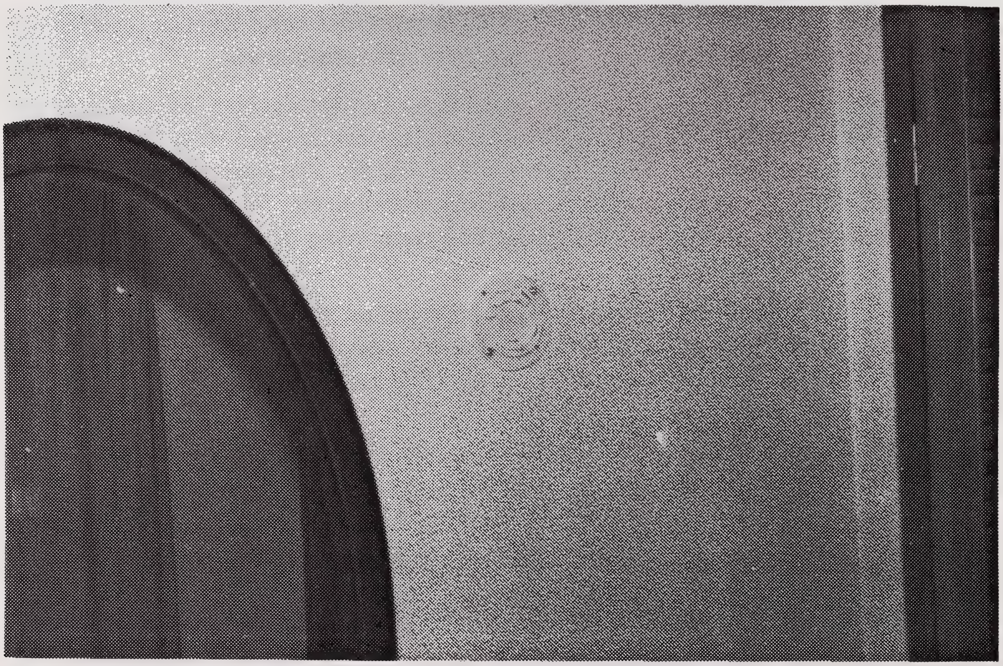


Figure C.2: INSTALLED BASE PLATE

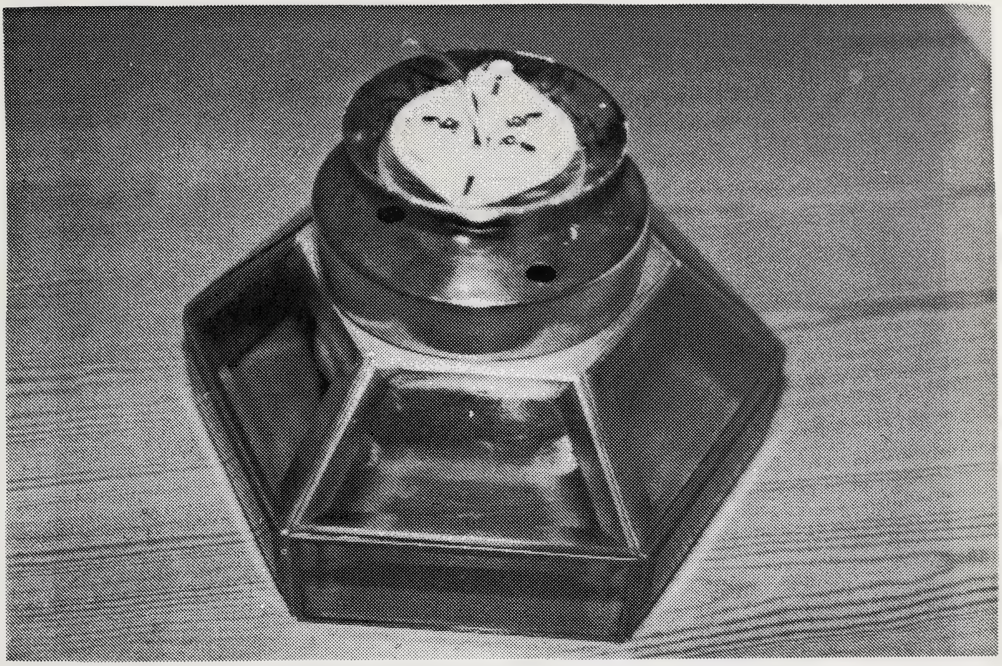


Figure C.3: ATTACHMENT PLATE WIRING AND MOUNTING

facilitate the safe and easy removal of fixtures for replacement or maintenance.

Several types, or styles, of pendant and two-point surface mounted incandescent, light fixtures may be mounted on an attachment plate. A two-point mounted fixture is illustrated in Figure C.3.

The supply wires from the fixture connect to the B, W, and G terminals of the attachment plate (Figure C.3). The fixture is mounted on the attachment plate by means of a pair of machine screws inserted through the attachment plate and secured by means of lock nuts, spacer nuts and decorative nuts. The height of the canopy is determined by adjustment of spacer nuts. The screws are maintained in a correct width position within the slots of the attachment plate with the lock nuts. The canopy is secured by the decorative nuts.

The height of the attachment plate relative to the fixture is determined by placing a ruler across the canopy. The alignment rim, which is the highest point on the base plate, should be at the same level as the canopy rim to achieve a close fit to the building surface (Figure C.3).

In a manufacturer adapted light fixture, mounting lugs are provided at the appropriate height. The fixture is secured to the attachment plate with screws that self-tap into the mounting lug.

Appendix D

Certification Documentation

Canadian Standards Association

1707 - 94th Street, Edmonton, Alberta, Canada T6N 1E6
Phone: (403) 450-2111 Telefax (403) 461-5322 Telex 037-2605

January 10, 1990

LR 88272-1

Pragmatic Electronics Limited
10819 - 63 Avenue
Edmonton, Alberta
T6H 1P9

Attention: Mr. Henry Hudson

Subject: **Fixture hanger, designated Q-Lock Connector, 120 V, 300 W.**

Dear Sir:

We have pleasure in informing you that the subject equipment, incorporating modifications required (if any), is considered to comply with the applicable CSA requirements. This equipment is therefore eligible to bear the CSA Mark in accordance with instructions contained in previous correspondence.

The Advisory Council on Electrical Safety comprising electrical inspection authorities throughout Canada will be informed that your equipment is being listed as CERTIFIED.

This certification is granted subject to CSA's findings being accepted by this Council.

There is no change to the Certification Record.

Yours truly,
CANADIAN STANDARDS ASSOCIATION

Glen Carlson

Glen Carlson
Engineer
Western Region

GC/jjj

The name of the Association is protected by letters patent of incorporation and its certification marks "CSA" and "®" are registered. CSA Marks and reports shall be used only in the manner and for the purposes authorized by CSA.

Canadian Standards Association

CERTIFICATION RECORD
January 10, 1990

Class 3426 01 (Re-examination Service) 88272

Pragmatic Electronics Limited
10819 - 63 Avenue
Edmonton, Alberta
T6H 1P9

Factory:

Same as Above

FIXTURES AND FITTINGS - Fixture Fittings

Fixture hanger, designated Q-Lock Connector, 120 V, 300 W.

LR 88272-1

GC/jjj

SIGNED Signed Copy in File

DATED October 24, 1989

Canadian Standards Association

178 Rexdale Blvd., Rexdale (Toronto), Ontario M9W 1R3

PROFILE OF CERTIFICATION REPORTS

FILE NO: LR 88272

SUBMITTOR

Pragmatic Electronics Limited
10819 - 63 Avenue
Edmonton, Alberta
T6H 1P9

Page No: CRP 1 of 1
Date: January 10, 1990

FACTORY	INSPECTION OFFICE	FILE NO
Same as Submittor	Western Region	LR 88272

Contact: Henry Hudson
(403) 450-5275

REPORT NO-APPL. NO	SUBJECT
-1	January 10, 1990 - Fixture hanger, designated Q-Lock Connector, 120 V, 300 W.

* * * * * * * * * * * *

Canadian Standards Association

178 Rexdale Blvd., Rexdale (Toronto), Ontario M9W 1R3

CERTIFICATION REPORT

REPORT NO: LR 88272-1

Edition 1: January 10, 1990; Application No LR 88272-1, Western Region
Issued by Glen Carlson, P. Eng.
Reviewed by Gary W. Boswell, P. Eng.

Contents: Pages 1 to 7
Figures 1 to 4
Photographs

CSA PRODUCT CLASS

3426 01 - FIXTURES AND FITTINGS - Fixture Fittings

SUBJECT

Fixture hanger, designated Q-Lock Connector, 120 V, 300 W.

It is the Submittor's responsibility to ensure that the CSA Mark is applied to this product only when the product complies with this report.

The name of the Association is protected by letters patent of incorporation and its certification marks "CSA" and "SP" are registered. CSA Marks and reports shall be used only in the manner and for the purposes authorized by CSA.

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DECLARATION

The product as described in this report complies with:

CSA Standard C22.2 No 0-M1982 - General Requirements - Canadian Electrical Code, Part II
No 0.4-M1982 - Bonding and Grounding of Electrical Equipment (Protective Grounding)
9-M1989 - Luminaries
42-M1984 - General use Receptacles, Attachment Plugs and similar wiring devices.

MARKING

Submittor's name or File No: "LR 88272", CSA Monogram, Cat No., date code or serial number traceable to month and year of manufacturer and electrical rating "120 VOLTS/300 WATTS", die-stamped, or printed on an Accepted pressure-sensitive nameplate attached to each connector. The date code may be marked with an approved ink stamp. A sheet or sheets of installation instructions and warnings are supplied in the package with each connector.

The installation and assembly instructions include warnings:

(a) To limit weight of luminaries hung by this device to 25 lbs;

(b) To ensure that the electricity is disconnected before removing or attaching the luminaire.

(c) To ensure that the canopy, after installation, will accommodate the wiring splices and that an opening does not appear between the canopy rim and ceiling.

(d) To ensure that the supply ground, after terminating on the electrical outlet box, is also connected to the Base Plate ground screw.

ALTERATIONS

(a) Markings are as above.

(b) The minimum thickness of the base plate is 2.5 mm in the area that is considered to complete the electrical enclosure.

(c) The probe, of Figure 1 CSA Std C22.2 No 9-M1989, can not contact bare live parts when the Base Plate is mounted by itself.

(d) A hardware package is included with the Q-Lock Connector as per item 7.

FACTORY TEST

None required, since live parts are insulated by plastic, i.e., there are no exposed non-current-carrying metal parts enclosing live parts.

DESCRIPTION

General:
The Q-Lock Connector is a device which permits, once initially installed, the easy re-installation and removal of interior, incandescent light fixtures to wall or ceiling electrical junction boxes.

1. A base plate (or female component) which is normally wired and attached to the electrical outlet box, and

2. An attachment plate (or male component) to which the light fixture is attached.

The base plate and attachment plate are connected by a simple rotation motion of the attachment plate with respect to the base plate. At the same time, electrical connections between the respective plates are made.

The Connector can be used with various types of fixtures that normally require a crossbar for mounting. In this case the crossbar is not used.

1. Base Plate: Shaped as per Photographs, and Figure 1.

    a) Material: CSA rated 0.6 V-0 for min thickness of 1.45 mm 'Monsanto', ABS911, tradename 'Lustran', color is beige.

    b) Dimensions: Diameter is 107 mm. Min thickness of the area that is considered to complete the enclosure is 2.5 mm. Min thickness of other ridges, flanges etc is 1.5 mm. Maximum depth is 10.5 mm.

    c) Screw Holes: Four, 4.6 dia holes, spaced at 90 degrees. Opposite holes are 89 mm apart.

    d) Mounting: Mounts directly to the lighting outlet box by two screws. The probe from Figure 1 (Clause 4.2.2.2) CSA Std C22.2 No 9-M1989, can not contact bare live parts when the base plate is mounted on an electrical lighting outlet box.

2. Attachment Plate: Shaped as per Photographs, and Figure 1.

    a) Material: Same as Base Plate.

    b) Dimensions: Long dimension is 112 mm, short dimension is 83 mm. Minimum thickness is 1.5 mm. Maximum depth is 15.6 mm.

c) Screw Holes: Two slotted openings 29 mm long, 3.7 mm wide.

d) Mounting:

i) Surface Luminaire: An electrician will attach the plate, by screws, decorative nuts and spacer nuts, directly to the canopy. Refer to Figure 2.

The screws and decorative nut are normally supplied with the fixture, the spacer nuts are supplied with the Q-Lock connector.

ii) Stem Pendent Luminaire: An electrican will attach the plate to the threaded end of the tubular rod by two hex nuts. Refer to Figure 3. The plate has an integral molded socket which accepts one hex nut. The other hex nut is tightened against the grounding connector on the opposite side of the plate. The hex nuts are supplied with the Q-Lock connector. The canopy mounts over the plate in the normal way, it slides up the tubular rod until it contacts the ceiling and is then secured by a ring-set screw device.

iii) Cord and Chain Pendent Luminaire: The method of installation will be similar to the stem pendent. The original method of strain relief used by the fixture manufacturer must remain unchanged. Refer to Figures 3 and 4.

3. Wire Binding Clamps: Neutral terminals are identified by being a white color metal or marked W or WHITE adjacent to the terminal. Ground terminals are identified by a green colored screw head.

a) Screw: Copper alloy, uncoated, round slotted head of 5 mm dia, threaded shaft 6 mm in length, thread size 4-40.

b) Nut: Same material as screw, 4.6 mm dia, thread depth 5 mm. Burred outer surface, integrally molded into plastic. The nut for the ground wire extends through the plate and accepts a second screw, on the opposite end which secures the grounding connector (item 5) and completes the grounding path.

c) Movable Clamp: Same material as screw, 0.83 mm thick, 7.7 mm wide, 8.9 mm long, shaped bend at one end, 1 mm deep to accept 14 AWG wire.

d) Fixed Clamp Backing:

i) Attachment Plate: The movable clamp holds the equipment wire against the male contact (item 4a).

ii) Base Plate: The movable clamp holds the equipment wire against the Female Contact.

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Note: Screw engages at least two complete clean-cut full threads after installation of 14 AWG wire.

4. Electrical Contacts:

   a) Male:

      i) Material: Copper alloy, 0.86 mm thick.

      ii) Dimensions: Overall 18 mm by 7.7 mm with a 5 mm offset formed by two 90 degree bends.

         Contact portion is 8.5 mm long, by 4.8 mm wide with circular end.

      iii) Mounting: Fits tight into molded openings integral to attachment plate. Held by screw and clamp, items 3a and 3c.

   b) Female:

      i) Material: Copper alloy, 0.41 mm thick.

      ii) Dimensions: Overall 24 mm by 2.1 mm (max), the contact portion (5.75 mm wide) is bent into a U shape, 12 mm high, 7 mm wide (max).

      iii) Mounting: Fits tight into molded openings integral to the base plate. Held by screw and clamp, items 3a and 3c.

5. Grounding Connector:

   a) Material: Copper alloy, 0.26 mm thick.

   b) Dimensions: Overall 63 mm long, 30 mm wide (max), 10 mm wide (min). Shaped as per Photograph.

   c) Mounting: Secured by a plated metal screw, turned into the opposite end of the ground wire binding clamp nut (item 3b). Held in alignment by a second size #4, 1/8 in, self taping, plated metal screw or metal rivet.

   d) Purpose: Provides an electrical ground path from the electrical box to the fixture.

6. Grounding: The ground path from electrical outlet box to fixture is by the following.

   i) Ground screw on Base Plate
   ii) Female electrical contact
   iii) Male electrical contact
   iv) Grounding connector on Attachment Plate.

   Note: Grounding of the fixture is dependent on the supply ground being terminated on the ground screw on the Base Plate in addition to its normal termination on the electrical outlet box ground screw. Hence the warning to this effect.

7. Hardware: The following hardware is supplied loose to be used as required for mounting:

   a) Four plated hex nuts, size 8-32, used to mount attachment plate to canopy on surface luminaires.

   b) Two plated hex nuts, size 3/8 in x 9/16 head, used to mount attachment plate to the tubular rod on pendant luminaires.

TESTS

Per CSA Standard C22.2 No 9-M1987

Dielectric Strength: Cl 6.6

Withstood for 1 min without breakdown, an applied voltage of 1000 V ac, 60 Hz, between current-carrying parts and ground.

Loading: Cl 6.14

Supported a load of 150 pounds for 1 hour.

Probe Test: Cl 4.2.2.2

Probe could not contact bare live parts when the device was mounted as follows:

i) Base Plate by itself.

ii) Base Plate with Attachment Plate attached.

Per CSA Standard C22.2 No 0.4-M1982

Bond Impedance: Cl 4.1

Conditions: 30 A, 2 min

Results: Voltage drop 0.318 V, satisfactory.

Per CSA Standard C22.2 No 42-M1984.

Overload: Cl 7.8

Conditions: 100 cycles, 120 V ac, 60 Hz, 22.5 A.

Results: Pass

Temperature: Cl 7.9

Conditions: 120 V ac, 60 Hz, 300 W load.

Thermocouple Location	Max Temp Deg C
Wiring (line 1 cm from connector)	30
Neutral Terminal	30
Wiring (load)	30
Ambient	25

Resistance to Arcing: Cl 7.17

Conditions: Additional 50 cycles as per Cl 7.8

Results: Pass

Screw Tightness: Cl 7.23

Conditions: 1.6 mm (14.2 in lbs)

Results: No damage to the device terminal.

1655 Scott Boulevard
Santa Clara, California 95050-4169
(408) 985-2400
FAX No. (408) 296-3256
MCI Mail No. 259-3283
Cable ULINC SANTA CLARA CA
Telex No. (TRT) 184-219

UL Underwriters Laboratories Inc.

E126119 August 15, 1990

PRAGMATIC ELECTRONICS LTD.
Edmonton, Alberta, CANADA

Fax No:

Attention: Mr. Henry R. Hudson

Reference: File E126119, Project 89SC12601

Subject: Preliminary Investigation Of Q Lock Light Fixture Connector

Dear Mr. Hudson:

We have completed our preliminary investigation of the subject product and this letter will serve as the report of our findings. The scope of this investigation was to determine the applicable requirements, the tests to be performed, the number of samples required and the cost limit for an investigation under the category of Fixture Fittings.

For record purposes, the polymeric connector acts to replace the traditional cross-bar hanger for surface-mounted incandescent lighting fixtures, as well as to provide electrical connections between the fixture and electrical outlet-box. The connector has two components: (1) a base plate that is electrically wired and fixed by screws to the electrical outlet box; and (2) an attachment plate that is built into or retrofitted to a light fixture. These components are joined by a pushing together and a partial rotation to provide mechanical and electrical connections.

The product's construction was examined and the following are our comments. All references are to the Standard for Incandescent Lighting Fixtures, UL 1571.

1. Upon reviewing the connector sample, as well as the instructions for installation provided in your" Revised Product Description and Regulatory Requirements," dated October 24, 1989, we noted that the lighting fixture and attachment plate to which it is secured would not be

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prevented from turning or shifting in position by means other than friction between the surfaces once installed. Per paragraph 23.18, this is not acceptable.

2. Paragraph 56.10 currently specifies that a non-polymeric part (such as a metal fixture) that weights more than 2 lbs cannot be supported by a polymeric material. As with paragraph 36.9, our staff has agreed to propose to delete this requirement. However, before we can accept the current "Q Lock" connector construction, the proposal to delete the requirement must first be presented to the fixture industry and then adopted. UL is in the process of drafting a proposal bulletin.

3. We have also recommended that a new requirement be added that would provide for minimum requirements for any fixture mounting means of polymeric materials. The proposal will require a minimum flame of rating of 94V-1, a temperature rating of at least 80°C, and a minimum weight limit capability for supporting at least four times the maximum anticipated load of a fixture when placed in an ambient temperature of 10°C above the minimum supply wire temperature rating of the fixture, but no less than 100°C. The maximum weight of a fixture would be 50 lbs.

This letter completes the work anticipated for Project 89SC12601. We are therefore closing the project and notifying our Accounting Department to invoice your company for charges accrued.

Should you have any questions or comments concerning this letter, please do not hesitate to contact us.

Very truly yours,

Margaret Kiefer

MARGARET KIEFER
Associate Project Engineer
Electrical Department

Reviewed by:

James W. Richards

JAMES RICHARDS
Staff Engineer
Electrical Department

N.L.C. - B.N.C.
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